

**Rebuilding Naturally Spawning Coho Salmon Stocks: An Assessment of  
By-Catch Reduction Measures and Spawning Escapement Stock Composition in the  
Southern Puget Sound (Fishery Management Area 13D-K)**

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**Abstract**

We examined the contribution of natural coho salmon to the total coho salmon harvest in the Squaxin Island Tribes commercial coho salmon fishery during the 1999 and 2000 commercial fisheries, and the contribution of hatchery strays to coho salmon escapement in local streams. Commercial harvest during the two years was extremely variable. The 1999 harvest (5,282) was the lowest on record, while the 2000 harvest (77,847) was within the range observed during the past decade. Natural coho salmon contributed 5 percent or less of the total harvest during both years. This resulted in estimates of 131 and 3,808 natural coho salmon being intercepted in the 1999 and 2000 commercial coho salmon fisheries, respectively. Although these are relatively small numbers, they represented between 16 and 129 percent of the total escapement of coho salmon (both natural and hatchery) to local streams.

The contribution of hatchery strays to escapement in local streams was spatially and temporally variable. Hatchery strays contributed a greater proportion of the total escapement during 1999 and 2000 in two local streams trapped using weirs. The proportion of hatchery strays observed in Mill Creek were more than twice that observed in Cranberry Creek. However, sample sizes were small (n = 12 to 75) for these streams. The proportion of coho salmon carcasses sampled

during foot surveys found to be hatchery origin based on adipose fin clips varied from 0 to 88.9 percent for five streams. Sample sizes were extremely small ( $n = 1$  to 9) for all but one stream ( $n = 79$ ). Overall, 32.2 percent of all coho salmon sampled in local streams were hatchery strays.

Results from this study will be used to reduce the interception of natural coho salmon in the Squaxin Island Tribes commercial coho salmon fishery. They will also be used to improve estimates of natural coho salmon escapement into local streams and provide insight into means of limiting the influence of hatchery strays on local streams.

## Table of Contents

<a href="#">List of Figures</a> .....	iv
<a href="#">List of Tables</a> .....	v
<a href="#">Executive Summary</a> .....	vi
<a href="#">I. Purpose</a> .....	1
<a href="#">I.1. Study Area</a> .....	2
<a href="#">II. Approach</a> .....	4
<a href="#">II.1. Sampling Commercial Catch</a> .....	4
<a href="#">II.2. Adult Weir Traps and Stream Surveys</a> .....	4
<a href="#">II.3. Determining Origin of Coho Salmon</a> .....	5
<a href="#">II.4. Statistical Design and Analysis</a> .....	5
<a href="#">II.5. Natural/Hatchery Contribution to Commercial Fishery</a> .....	6
<a href="#">II.6. Natural/Hatchery Contribution to Escapement</a> .....	7
<a href="#">II.7. Project Management</a> .....	7
<a href="#">III. Findings</a> .....	8
<a href="#">III.1. Commercial Harvest</a> .....	8
<a href="#">III.2. Contribution of Hatchery Coho to Escapement</a> .....	10
<a href="#">III.2.A. Adult Trapping</a> .....	10
<a href="#">III.2.B. Stream Foot Surveys</a> .....	10
<a href="#">III.3. Accuracy of Scale Reading Methodology</a> .....	10
<a href="#">III.4. Discussion</a> .....	11
<a href="#">III.5. Management Implications</a> .....	14
<a href="#">IV. Evaluation</a> .....	16
<a href="#">V. Literature cited</a> .....	18

## List of Figures

<u>Figure 1.-Areas where coho salmon were sampled in the commercial fishery (Dana Passage 13D1, Pickering Passage 13D2, Peale Passage 13D3, Southern Case Inlet 13D4), in stream weirs (Cranberry and Mill Creeks), and during foot surveys (Schumacher, Rocky, Woodland, Skookum, Skookum Tributary 14.0024, and Rock Creeks).....</u>	26
<u>Figure 2.-Cumulative percent of hatchery and wild coho salmon sampled for scales during 1999 (A) and 2000 (B) commercial fishery. ....</u>	27

## List of Tables

<a href="#"><u>Table 1. -Total coho salmon catch by gear type and area during 1999 and 2000.</u></a>	20
<a href="#"><u>Table 2.-Number<sup>1</sup> of coho salmon sampled from the 1999 and 2000 commercial fishery classified as natural and hatchery for each catch area and month using visual scale analysis. The number of fish originally classified as unknown is also shown. These fish were separated into natural and hatchery groups based on the proportions of hatchery and natural coho salmon that could be classified.</u></a>	21
<a href="#"><u>Table 3.-Estimated percent of natural and hatchery origin coho salmon in samples for each catch area during September and October of the 1999 and 2000 commercial fishing season based on visual scale analysis.</u></a>	22
<a href="#"><u>Table 4.-Estimated total catch of natural and hatchery origin coho salmon for each catch area during September and October of the 1999 and 2000 commercial fishing season.</u></a>	23
<a href="#"><u>Table 5.-Total catches of each salmonid species observed in Mill and Cranberry Creeks during 1999 and 2000.</u></a>	24
<a href="#"><u>Table 6.-Number (percent) of coho salmon caught in Mill and Cranberry Creeks' classified as natural, hatchery, and unknown during 1999 and 2000.</u></a>	24
<a href="#"><u>Table 7.-Number coho salmon carcasses examined for adipose marks, and the number and percent of natural and hatchery coho salmon in the sample obtained during foot surveys during 2000.</u></a>	25

## **Executive Summary**

We examined the contribution of natural coho salmon to the total coho salmon harvest in the Squaxin Island Tribes commercial coho salmon fishery during the 1999 and 2000 commercial fisheries, and the contribution of hatchery strays to coho salmon escapement in local streams. Sampling the catch and determining the proportions of natural and hatchery origin adults using scale analysis was used to assess the interception of natural coho salmon in the commercial fishery. Samples and catch were collected for four separate catch areas during both seasons. However, estimates of natural and hatchery origin coho salmon could only be calculated for three of the four areas.

Commercial harvest during the two years was extremely variable. The 1999 harvest (5,282) was the lowest on record, while the 2000 harvest (77,847) was within the range observed during the past decade. Natural coho salmon contributed 5 percent or less of the total harvest during both years. This resulted in estimates of 131 and 3,808 natural coho salmon being intercepted in the 1999 and 2000 commercial coho salmon fisheries, respectively. Although these are relatively small numbers they represented between 16 and 129 percent of the total escapement of coho salmon (both natural and hatchery) to local streams.

Contribution of natural coho salmon to the commercial harvest varied by catch area and by month. The proportion of natural coho salmon present in the harvest was greater than expected for Pickering Passage when controlling for the affect of month. The proportion of natural coho salmon present in the harvest was also greater in October than September. Greater proportions of natural coho salmon in the harvest in certain areas or during certain periods didn't result in numerically more natural coho salmon being intercepted, due to differences in harvest levels among areas and month.

These results suggest that area or temporal closures would have limited benefits for reducing the total numbers of natural coho salmon intercepted in the fishery. Based on these findings, release of non-adipose clipped coho salmon (natural origin coho salmon) may be the best alternative for reducing the interception of natural coho salmon in the fishery. This alternative should be studied prior to full implementation. Non-adipose clipped fish may be caught and released numerous times prior to escaping into waters closed to commercial harvest, which may significantly reduce any benefits of the release requirement.

The contribution of hatchery strays to local streams was evaluated using weirs on two local streams and foot surveys on five additional streams. Hatchery contribution in the two streams with weirs was assessed using scale analysis, while it was assessed using the adipose marks for streams sampled during foot surveys. The contribution of hatchery strays to local streams was spatially and temporally variable. Hatchery strays contributed between 5.3 and 58 percent of total escapement during 1999 and 2000 in the two streams trapped with weirs. Hatchery strays contributed a greater proportion of the total escapement during 1999 and 2000 in two streams trapped using weirs. The proportion of hatchery strays observed in Mill Creek were more than twice that observed in Cranberry Creek. However, sample sizes were small ( $n = 12$  to 75) for

these streams. The proportion of coho salmon carcasses sampled during foot surveys found to be hatchery origin based on adipose fin clips varied from 0 to 88.9 percent for five streams. However, sample sizes were extremely small ( $n = 1$  to 9) for all but one stream ( $n = 79$ ). Hatchery origin coho salmon constituted 32.2 percent of all coho salmon sampled in local streams during 2000.

Estimates of hatchery contribution to the overall coho salmon escapement in local streams could be made using two different methods. All samples could be combined to calculate an overall estimate of hatchery contribution. The advantage of this method is that large sample sizes are obtained which should reduce the variability of the estimates. The disadvantage of this method is that it assumes that hatchery contribution is the same among all the streams. Our data show that this assumption is false.

An alternate method would be to use estimates of hatchery contribution to each index stream used to calculate coho salmon escapement in area 13D-K streams. Area under the curve estimates for each stream could then be adjusted for hatchery and natural contribution. These adjusted values would then be used to estimate overall escapement of natural and hatchery coho salmon to area 13D-K streams. This method has the advantage of accounting for variation in hatchery contribution to escapement among local streams. It has the disadvantage of small sample sizes, which would increase the variance of the estimates.

We did not estimate hatchery contribution to local escapement in 1999 or 2000. No foot survey data was available for 1999. This data was available for only half the index streams used to calculate coho escapement in area 13D-K streams during 2000. Therefore, no meaningful comparisons of these two methods could be made using available data.

Results from this study will be used to reduce the interception of natural coho salmon in the Squaxin Island Tribes commercial coho salmon fishery. They will also be used to improve estimates of natural coho salmon escapement into local streams and provide insight into means of limiting the influence of strays on local streams.

## **I. Purpose**

The Squaxin Island Indian Tribe has utilized Pacific salmon returning to the Tribe's Usual and Accustomed fishing area for over 6,000 years. Deep southern Puget Sound is a historically productive salmon producing area defined by numerous, low gradient creeks that flow through conifer forests. Puget Sound coho salmon stocks are currently depressed due to habitat degradation, and high commercial and sport fishery interception rates.

In response to diminishing returns of naturally spawned coho salmon to south Puget Sound, The Squaxin Island Tribe and The State of Washington joined in a cooperative enhancement effort in 1974. The Squaxin Island saltwater net-pen facility was created to enhance commercial and sport harvest opportunities throughout Washington, but in Deep South Sound in particular. In 1981, the Fisheries Advisory Board (FAB) determined that south Puget Sound coho stocks should be considered “nonviable” and managed for hatchery harvest rates. Hatchery exploitation rates are higher than harvest rates on natural stock that consider only targeted escapement goals for hatchery brood stock and no additional natural escapement goals. The recommendation of the FAB prompted an expansion of the Squaxin Island net-pen facilities in 1982 to assure fishing opportunities for terminal area fisheries. Approximately 2.4 million coho salmon smolts have been released on an annual basis since 1983.

The Squaxin Island net-pen facility contributes substantially to the annual commercial and sport coho harvest in Washington, northern Oregon, and Canada. The returning net-pen reared fish provide the Squaxin Island Tribe with its only opportunity for commercial coho harvest. However, there is the potential of intercepting naturally produced coho salmon during commercial fisheries targeting net-pen fish. To date, there has been no examination of the interception of natural fish in the Tribes commercial coho salmon fishery.

The Squaxin Island Tribe believes there is direct benefit to the fishing community, both Treaty and Non-treaty commercial and sport, by maintaining sustainable escapement of natural spawning coho salmon in deep southern Puget Sound. The long-term goal of the Tribe is to rebuild the natural spawning coho stocks in deep southern Puget Sound to provide future, sustainable harvest opportunities and conserve the population. Management of harvest patterns on returning adult salmon, while maintaining an economically viable fishery will influence the success of a natural stock-rebuilding program. To both rebuild natural stocks and maintain the net-pen program, several knowledge gaps need to be filled and related assumptions verified.

In addition, information is needed to determine the number of net-pen reared (hatchery) coho salmon that stray into local streams. The stock composition of the escapement into Management Area 13 D-K streams is currently unknown. The stock composition of coho salmon escaping into area 13 D-K streams was examined in a cooperative investigation between the U.S. Fish and Wildlife Service (USFWS) and the Squaxin Island Tribe for the 1974 to 1979 broods. These fish returned during 1977 to 1982 and total recovery of the six broods averaged 17.1 percent. An estimated 0.3% (837) of the total 1976 release was found to have spawned in streams near the

net-pen site (Rensel et al. 1988). The authors estimated that net-pen strays contributed between 700 and 4,000 coho salmon annually to local escapement during the period. Run reconstruction estimates of then natural escapement in 13D-K streams, for the period 1977 to 1982, averaged 7,833 fish (WDFW et al. 1992). Thus, net-pen strays were estimated to contribute between 7 and 51 percent of the total escapement during this period. However, the release of hatchery coho salmon from this facility has increased nearly 10-fold since this study. Coho salmon escapement in this area has also decreased, averaging 3,850 fish from 1989 to 1998. The 1999 escapement of 800 coho salmon was substantially less than the 10-year average. The Squaxin Island Tribe has also since modified their commercial harvest technique since this study was conducted; using beach seines almost exclusively in the commercial coho fishery. The harvest method is very effective at targeting returning net-pen coho. They have further concentrated coho harvest efforts around the location of the net-pen site and terminal area inlets have been closed to protect naturally spawned coho salmon.

In Washington, coho released off-station tended to stray to other watersheds more than coho released at the hatchery (VanderHaegen and Doty 1995). Less than 1% of coho salmon released from a hatchery strayed to other locations, whereas 1.6 to 55% of coho salmon released off-station was recovered as strays (VanderHaegen and Doty 1995).

A study to investigate the contribution of hatchery and net-pen origin coho straying into streams in Hood Canal and Grays Harbor during 1995, concluded that straying of coho salmon reared at the Port Gamble Bay and Quilcene Bay net-pen may be more than 2.4 times greater than Quilcene National Fish Hatchery coho (NRC 1997). These conclusions were based, in part, on visual scale pattern analysis to distinguish natural from hatchery origin fish. The study found that 39% of the coho recovered in north Hood Canal streams were net-pen origin fish. However, the study was less conclusive when evaluating the extent of net-pen coho straying in Grays Harbor. The study concluded that few cultured fish were recovered in the Westport area (NRC 1997). Due to the variability in net-pen straying observed in the NRC study, it is impossible to determine the stray rates of coho salmon released from the Squaxin Island net-pens from this study.

The primary objectives of this study were to 1/ estimate the abundance and distribution of hatchery and naturally spawned coho salmon contributing to the Squaxin Island Tribal commercial fishery; and 2/ assess the straying rate of hatchery origin fish into natural spawning populations in Area 13D-K streams. This information is required to reduce any impacts of the commercial fishery on naturally spawning coho salmon, while maximizing the utilization of the net-pen coho salmon and limiting escapement of net-pen coho salmon to local streams.

## I.1. Study Area

This study took place in deep southern Puget Sound (Figure 1). Commercial catch sampling was conducted in Dana Passage (area 13D-1), Pickering Passage (catch area 13D-2), Peale Passage (catch area 13D-3), and Southern Case Inlet (catch area 13D-4). These catch areas are described

by the Squaxin Island Tribes commercial fishery regulations as:

- 13D-1 Dana Passage: All marine waters west of a line projecting northwest from Johnson Point to Wilson Point on Hartstene Island. Dana Passage is bordered to the south by a line projected from Cooper Point to the light at Dofflemeyer Point near Boston Harbor, and a line projected from Cooper Point to the southeastern shore of Sanderson Harbor. Dana Passage is bordered to the north by a line projecting northeast from Dickerson Point to Johnson Point. Dana Passage is bordered on the west by a line connecting Brisco Point light on Hartstene Island with Unsal Point on Squaxin Island, and a line connecting Unsal Point on Squaxin Island to the Hunter Point light on the mainland.
- 13D-2 Pickering Passage: All marine waters south of a line projecting north from Dougall Point on Hartstene Island to the southernmost tip of Stretch Island, south of the Stretch Island Bridge (Pirates Cove), and north of a line projecting northwest from Unsal Point on Squaxin Island to the Hunter Point light on the mainland. Pickering Passage is bounded on the west by lines projected across the mouths of Hammersley and Totten Inlets.
- 13D-3 Peale Passage: All marine waters south of a line projecting due east from Salmon Point on the northern tip of Squaxin Island. To the bulkhead on Hartstene Island, approximately due east of Salmon Point, and all waters north of a line connecting Brisco Point light on Hartstene Island with Unsal Point on Squaxin Island.
- 13D-4 Southern Case Inlet: All marine waters north of a line projecting southwest from Treble Point (Anderson Island) through the navigation marker (southwest of Treble Point) to the mainland and all waters south of a line between Devils Head and Treble Point. Southern Case Inlet is closed to the west by the previously described lines across Dana and Pickering Passages, and south of a line projected due east from the southern tip of Stretch Island to the Longbranch Peninsula.

Adult coho salmon in Cranberry and Mill Creeks were trapped during their spawning migration during both 1999 and 2000. These drainages have been described previously by Williams et al. (1975). Mill Creek originates as Gosnell Creek in the foothills southeast of the town of Shelton. Rock Creek, which is a tributary to Gosnell Creek, serves as a coho salmon spawning survey index reach for south Puget Sound area 13D-K streams. Gosnell Creek flows into Lake Isabella. Mill Creek provides the outlet of Lake Isabella, and flows for just under nine miles to the south shoreline of Hammersley Inlet. Cranberry Creek originates in a swampy region north of the town of Shelton. It flows into Cranberry Lake (69 hectares) and then into Lake Limerick, a man-made lake approximately the same size as Cranberry Lake. Cranberry Creek enters Puget Sound at the northern extend of Oakland Bay in Hammersley Inlet.

Foot surveys were completed on Woodland Creek, Schumacher Creek, Rocky Creek, Skookum Creek, and an unnamed tributary of Skookum Creek described as 14.0024 Creek (Williams et al. 1975). Woodland Creek originates in near the city of Lacey and flows north through sprawling residential development, second growth forest and open pastures to its terminus at the southern

end of Henderson Inlet. Schumacher Creek begins approximately 9 km north of Shelton and flows east until it enters the east end of Mason Lake. Mason Lake is drained by Sherwood Creek, which flows north to northeast until it enters Case Inlet near the town of Allyn. Rocky Creek originates on the east side of Case Inlet and flows southwest until it enters Rocky bay on the eastern shore of Case Inlet. Skookum Creek originates in the foothills southwest of Shelton. It flows through second growth forest, open pastures, and sparse residential development until it enters Little Skookum Inlet, which later enters Totten Inlet. The unnamed Skookum Creek tributary (14.0024) enters Skookum Creek from the north at about the mid-point of Skookum Creek, after originating in the foothills southwest of Shelton.

## **II. Approach**

### **II.1. Sampling Commercial Catch**

Coho salmon delivered to dockside buyers by Squaxin Island Tribe commercial fishers were sampled for adipose clips and electronically scanned for CWTs. The snouts from tagged fish were removed and labeled, and scale samples were taken from a sub-sample of 71 to 656 fish per area per month. Three catch areas were sampled during 1999 and four during 2000: Peale Passage (sub-area 13D-3) which is the east side of Squaxin Island and the location of the net-pens, Pickering Passage (sub-area 13D-2) which includes the west side of Squaxin Island and continues north to Southern Case Inlet, Dana Passage (sub area 13D-1) which includes the south end of Squaxin Island, were sampled during 1999. These same areas and Southern Case Inlet (13D-4) were sampled during 2000 (Figure 1). Fishers selling coho salmon to buyers were asked to indicate the specific location where their fish were caught.

The data collected from the commercial fishery was used to estimate the proportion of the Squaxin Island Tribe commercial coho catch that was composed of natural and hatchery origin coho, and the spatial and temporal distribution of natural spawn and hatchery adults in the catch.

### **II.2. Adult Weir Traps and Stream Surveys**

Information about coho salmon spawning escapement into deep southern Puget Sound streams were collected from adult weir traps during 1999 and 2000 and stream foot surveys during 2000. Adult weir trap were installed on Mill Creek and Cranberry Creeks (Figure 1). These sites were selected based on the number of coho observed at index sites during the previous year's spawning surveys. The two creeks were among those creeks where larger populations of spawning coho were counted, there is historical information available and they are amenable to trapping.

Coho salmon caught in each weir were enumerated daily. All adult coho were examined for an adipose fin clip, electronically scanned for CWTs, and a sample of six scales was removed.

Coho salmon carcasses encountered during foot surveys on selected streams were examined for adipose clips and scanned for CWTs by the Washington State Department of Fish and Wildlife (WDFW). Carcasses were examined during foot surveys of Woodland, Schumacher, Rocky, and Skookum Creeks, and a tributary of Skookum Creek (14.0024). The snouts from tagged fish were removed and labeled. These snouts were frozen until they could be dissected and tags removed. Dissecting and tag reading was completed by WDFW following standard procedures. These data were used to estimate the proportion of natural spawn and hatchery origin coho spawning in local streams.

### II.3. Determining Origin of Coho Salmon

Origin of coho salmon sampled in the commercial fishery and weirs was determined using scale growth patterns (Cook 1982, Bernard and Myers 1996). The technique of visual scale pattern analysis has the advantage over CWT recovery because the fish do not have to be sacrificed to classify origin, and all fish sampled in the study area can be classified to origin, not just those previously marked prior to release. Therefore, the proportion of hatchery straying and natural spawning fish can be determined within the study area quickly and accurately. This method also provides potentially higher statistical accuracy and power due to increased sample sizes. Some scales couldn't be classified as natural or hatchery (<10%). These 'unknown' fish were divided into natural and hatchery origin groups based on the percentages of natural and hatchery origin fish observed in those scales that could be classified to origin.

Scale validation sets unique to south Puget Sound natural and hatchery stocks were not collected during this study. Therefore, we couldn't calculate variances for our estimates. We estimated the error rates for hatchery origin fish sampled during the 1999 commercial fisheries using adipose marked fish (known hatchery origin). The percentage of these hatchery origin fish subsequently classified as natural origin by scale readers provided an estimate of classification error. However, these error rates could not be used to calculate variances because this would violate the basic assumption of independence (Pella and Robertson, Cook 1982). The presence of adipose marks was not recorded during the 2000 commercial fishery, and too few fish were captured in the traps to provide meaningful comparisons of error rates.

### II.4. Statistical Design and Analysis

Coho salmon taken in the Squaxin Island Tribe commercial fisheries, caught at the stream weirs, and in Area 13 D-K streams during foot surveys were divided into two components; hatchery fish and naturally spawned fish from South Sound streams. The proportional contribution of these components was estimated using the estimated proportion of hatchery and natural origin coho salmon from scale samples and based on adipose marks (foot surveys).

We tested the hypothesis that the contribution of natural coho salmon was independent of catch area and month using three-dimensional contingency tables and chi-square analysis. The

contingency table consisted of two rows (hatchery, natural), three (1999) or four (2000) columns (catch areas), and two tiers (September, October). If the initial hypothesis was rejected then we continued the analysis chi-square of conditional independence to determine if proportionally more natural coho salmon were caught in certain catch areas or during different months.

We evaluated the timing of natural and hatchery coho salmon entering the commercial fishery using the scale samples collected. We calculated the cumulative percent of natural and hatchery coho observed in the samples as determined by scale analysis. We used the Kolmogorov-Smirnov goodness-of-fit test to test the hypothesis that the temporal timing of natural coho salmon catch did not differ from that of hatchery coho salmon.

## II.5. Natural/Hatchery Contribution to Commercial Fishery

Calculating the overall contribution of natural and hatchery coho salmon were made for two distinct time periods, September 10 through September 30, and October 1 through October 28 during both 1999 and 2000. This was done to insure that at least 100 fish were sampled from each catch sub-area during the observation period. This sample size was required to obtain the desired level of accuracy.

The total number of hatchery coho ( $n_{ht}$ ) and natural coho ( $n_{nt}$ ) in the catch was estimated through analysis of the scales collected. Historic sets of scales of known origin from throughout Washington State were used to classify scale samples taken from the fishery each month to estimate the proportion of natural and hatchery coho. The estimate of catch by component (hatchery or natural) was derived by:

$$n_{ht \text{ or } nt} = n_{total} * P_{ht \text{ or } nt}$$

Where  $n_{total}$  is the estimated total coho salmon harvest in the particular catch area and time strata of interest, and  $P_{ht \text{ or } nt}$  is the proportion of hatchery or natural coho salmon observed in the scale samples from that strata as determined by visual scale analysis. These analyses were calculated for fish caught by beach seines only, since very few coho were caught using set gillnets.

Variances could not be calculated because known validation sets of scales from local natural populations, hatchery populations, and the net-pens were not read to determine the accuracy of this method for these stocks. Error rates for other validation data sets could not be used due to large variation in the accuracy of this method among different populations. NRC (1997) found that Hood Canal and Grays Harbor hatchery stocks were correctly classified 90 and 94 percent of the time, and wild stocks were correctly classified 99 and 86 percent of the time, respectively. Assuming similar error rates to those reported in the NRC (1997) study, and sample sizes of 100-150 scales per stratum, the estimates of natural and hatchery origin coho salmon is expected to be at least within 10-12% of the true contribution 95% of the time. Hatchery coho salmon and net-pen coho salmon could not be separated using this method (John Sneva, WDFW, personal communication). Therefore, we report all data as hatchery origin. These fish are assumed to make up primarily net-pen coho; however, fish from WDFW's Minter Creek facility (Figure 1)

likely contribute to both Tribal harvest and escapement.

## II.6. Natural/Hatchery Contribution to Escapement

All coho salmon caught at the adult traps were sampled for scales. Therefore, no estimates were required to determine the contribution of naturally spawned and hatchery coho salmon to the escapement in the weired streams. Due to the low numbers of fish sampled at the weirs, the data was combined to estimate the number of hatchery and wild coho salmon contributing to escapement in these streams. These samples were combined in an attempt to obtain a sample size (100-150 fish) that would allow our estimates to be within 10-12% of the true contribution 95% of the time.

The proportion of adipose fin clips in sampled carcasses was used to estimate the contribution of hatchery coho salmon to the spawning escapement of local streams sampled during foot surveys. These data are reported simply as the percent of the sampled fish that were hatchery origin. No attempt was made to expand this data into a total estimate of hatchery contribution to total escapement in Deep South Sound area 13D-K streams, due to the number of methods that could be used to produce this estimate. Two of these methods are discussed in the discussion to provide an example of the variation of different methods.

## II.7. Project Management

Jeff Dickison, Senior Biologist, Squaxin Island Tribe. Project manager, proposal and project review, and project supervision.

Rebecca Bernard, Fish Biologist, Squaxin Island Tribe. Proposal submission, proposal budget, supervision of weir construction, day-to-day supervision of the project, initial data input and analysis, wrote progress reports.

Michelle Stevie, Habitat biologist, Squaxin Island Tribe. Weir operation assistance, data input, field surveys, and project review.

Marianna Alexandersdottir, Biometrician, Northwest Indian Fisheries Commission. Statistical sampling design, and proposal review.

Will Beattie, Senior Regional Biologist, Northwest Indian Fisheries Commission. Proposal and data review.

John Sneva, Fishery Biologist, Scale Lab, Resource Assessment Division, Washington Department of Fish and Wildlife. Subcontracted to press and analyze all salmon scales collected during the project.

Chuck Baranski, Area Fish Biologist, Field Studies, Washington Department of Fish and Wildlife. Oversaw WDFW spawning surveys in Area 13D-K and collection of adult carcass samples, and data analysis for these samples. Provide escapement estimates of Area 13D-K creeks and project data review.

Dave Sieler, Natural Production Biologist, Resource Assessment Division, Washington Department of Fish and Wildlife. Oversaw adult trapping weir installation and provided technical operating advice.

Roger Peters, Fishery Biologist/Tribal Member. Subcontracted to complete data analysis and write final report.

### **III. Findings**

#### **III.1. Commercial Harvest**

Commercial harvest of coho salmon varied substantially between 1999 and 2000, with nearly 15-times more coho caught during 2000 than 1999 (Table 1). Fewer than 6,000 coho salmon were harvested by Tribal fishers during 1999, while more than 77,000 coho salmon were harvested in 2000. Areas contributing to overall harvest also differed between the two years. Landings occurred in areas 13A (Carr Inlet) and 13C (Chambers Creek) during 1999, but not during 2000. In contrast, landings were recorded for 13D4 (Southern Case Inlet) during 2000, but not during 1999. The proportion of the total catch caught in set nets was also lower in 2000 (2.4%) than in 1999 (4.9%).

Coho salmon were landed during the first day of the commercial fishery (September 10) in Peale Passage during both years. The first landing for Dana Passage was made on September 12 during 1999 and September 10 during 2000. The first landing for Pickering Passage occurred on September 12 during 1999 and September 14 during 2000. The last commercial coho salmon landings in Peale Passage occurred much earlier, October 16, 1999 and October 19, 2000, than either Dana Passage or Pickering Passage. Final landings in Dana Passage were made on October 28, 1999 and October 13, 2000, and October 28, 1999 and November 5, 2000 in Pickering Passage.

A total of 1,974 and 2,349 fish were sampled for scales during 1999 and 2000, respectively (Table 2). Sample sizes for each sample area and month strata ranged from 71 to 656 coho salmon. Only two fish were sampled from Case Inlet during 1999. Less than 10 percent of the coho sampled could not be classified as hatchery or wild. The number of fish sampled varied by area for each sampling period and each year. Over half the coho sampled during the 1999 commercial season originated from Peale Passage and the fewest number were sampled from Pickering Passage. In contrast, greater numbers of coho were sampled from Pickering Passage and the fewest were sampled from Dana Passage during 2000. Nearly equal numbers were

sampled in September and October 1999. However, nearly three times as many coho were sampled in October than in September 2000.

We could only compare the proportion of natural coho salmon contributing to the total catch in Dana Passage, Pickering Passage, and Peale Passage. We didn't include southern Case Inlet because no fish were caught there during 1999. There was also an error in recording catch from southern Case in 2000. A total of 265 coho were sampled from southern Case Inlet during 2000, 84 from September and 181 from October (Table 2). However, only 119 coho salmon were reported caught by beach seines in southern Case Inlet during 2000 (Table 1).

The proportion of the total catch estimated to consist of natural coho salmon varied by area and month during 1999 and 2000 (Chi-square:  $P < 0.0001$ ). Natural origin coho salmon contributed between 1.97 and 10.12 percent of the total catch (Table 3). The percentage of the total catch composed of natural origin coho salmon was greatest in Pickering Passage when controlling for the affect of month (Chi-square: 1999  $P \leq 0.0007$ ; 2000:  $P < 0.0001$ ). The proportion of natural origin coho in the total catch was greater in October than September in Pickering Passage. Although the proportion of natural coho in the total catch was more than twice as high during October than September during 1999 this difference was not statistically significant (Chi-square:  $P = 0.22$ ). The proportion of natural coho salmon caught during October was nearly twice as high during October than September during 2000 and this difference was significant (Chi-square:  $P < 0.0001$ ).

Increased percentages of natural origin coho salmon in the total catch didn't necessarily translate into larger numbers of natural coho salmon in the harvest. More natural origin coho salmon were caught in Pickering Passage during October than September during both 1999 and 2000 (Table 4). However, fewer natural origin coho salmon were harvested in Pickering Passage than Peale Passage during October 1999, even though the proportion of natural coho in the Pickering Passage harvest was nearly three times as high as in Peale Passage. This was due to the fact that the total harvest of coho salmon in Peale Passage was nearly five times as high as in Pickering Passage during 1999 (Table 1). Harvest of natural origin coho salmon was just over 10 percent greater in Pickering Passage than in Peale Passage during October of 2000. More natural coho salmon were harvested in Peale Passage than any other catch area during both 1999 and 2000. Harvest of natural coho salmon in Peale Passage made up more than 50 percent of the total harvest of natural coho salmon during both years. Harvest of natural origin coho salmon in Dana Passage was variable. It was comparable to harvest in Pickering Passage during 1999, but was much lower during 2000.

Hatchery fish entered the commercial fishery earlier (K-S test  $0.002 < P < 0.005$ ) than wild fish during both the 1999 and 2000 commercial fishing season, based on fish sampled for scales from the commercial fishery (Figure 2). This was most apparent for 1999 than during 2000. Cumulative percents of natural coho salmon caught during the season made significant increases shortly after October 10 during both years (Figure 2).

### III.2. Contribution of Hatchery Coho to Escapement

#### *III.2.A. Adult Trapping*

Total salmonid catches in the weirs varied by stream and by year (Table 5). Catches were approximately two times greater in 2000 than in 1999 for most species. Chum salmon catches increased more than ten-fold in 2000 compared to 1999. More coho salmon were trapped in Cranberry Creek than Mill Creek. However, many more chum salmon and cutthroat trout were trapped in Mill Creek than in Cranberry Creek.

Coho salmon returns to Mill and Cranberry Creeks' were much more protracted during 2000 than 1999. The first coho salmon were caught in the Mill and Cranberry weirs on October 31, 1999 and October 13, 1999, respectively. The last fish were caught on December 4, 1999 in Mill Creek and November 26, 1999 in Cranberry Creek. In contrast, the first fish were caught on October 11 and October 17 in Mill and Cranberry Creeks' during 2000, respectively. The last fish was caught on January 25, 2001 in Mill Creek and December 25, 2000 in Cranberry Creek.

Contribution of natural and hatchery produced coho salmon to escapement in Mill and Cranberry Creek varied by year and stream (Table 6). Hatchery contribution to escapement varied from a low of less than 6 percent to a high of 58 percent and was greater in 1999 than 2000. This was especially true for Mill Creek, where hatchery contribution was 58 percent in 1999 and less than 12 percent in 2000. Hatchery fish contributed more to the escapement of Mill Creek than Cranberry Creek during both years.

#### *III.2.B. Stream Foot Surveys*

Hatchery coho salmon made up 60.4 percent of the carcasses sampled during foot surveys (Table 7). The percentages varied substantially (0-88.9 percent) among the streams. However, sample sizes ( $n = 1$  to 9) for all streams except Rocky Creek ( $n = 79$ ) were extremely small.

### III.3. Accuracy of Scale Reading Methodology

A total of 1,973 fish sampled from the commercial fishery during 1999 were checked for both adipose clips and their origin determined by scale analysis. Adipose clipped coho (1,673) were correctly classified as hatchery origin using scale analysis 93.1% (1,557) of the time. Less than 1 percent (0.6%, 10) were incorrectly classified as natural spawning, and 6.3% (106) could not be classified as either hatchery or natural (classified as unknown). Unmarked coho (279) consisted of 205 hatchery, 53 natural, and 21 unknown origin. An additional 21 fish could not be identified as having or lacking an adipose fin (unknown mark group); 16 were classified as hatchery origin, 3 as natural, and 2 could not be classified (unknown). The presence/absence of

adipose fin clips was not noted for coho salmon sampled during the 2000 commercial season. Therefore, no estimates of classification error could be made for 2000.

### III.4 Discussion

Commercial coho salmon landings observed during 1999 were the lowest on record, while the 2000 commercial landings were within the range observed historically. Commercial coho salmon landings by the Squaxin Island Tribe have ranged from 5,279 to 221,000 (average (62,787) from 1975 to 1998, while releases have ranged from 185 thousand to 2.77 million (Squaxin Island Tribe, unpublished data). Low harvest numbers during 1999 likely reflected poor ocean conditions during the period these fish fed in the ocean. Increased harvest in 2000 likely reflected improved conditions in the ocean reflecting changes in the decadal ocean cycles that favor survival of Washington salmon stocks (see Hare et al. 1999 for review).

We estimated that a majority ( $\geq 95\%$ ) of the Squaxin Island Tribes commercial harvest was composed of hatchery fish. If we assume the estimates are within 10%, hatchery fish may have comprised from 85 to 100 percent of the total harvest. However, it's extremely unlikely that the Tribes commercial fishery harvested no natural fish.

We found that the estimated proportion of natural coho salmon in the harvest varied from 1.97 to 10.12 percent and was dependent upon catch area and month. The proportion of natural coho caught in the fishery was greater in October than September in all but one of the six comparisons over the two-year study. The proportion of natural coho was about twice as high in Pickering Passage during October compared to September during both years. Proportions of natural coho in the harvest were lowest in Peale Passage during 1999 and in Dana Passage during 2000. We only obtained data for Case Inlet during the 2000 commercial season. The proportion of coho in these samples during October was the highest observed ( $>10\%$ ). Greater proportions of natural coho in the harvest in Pickering Passage and during October, didn't translate into significantly more natural coho salmon caught in this area or time period. For example, the proportion of natural coho was twice as high and 22 percent as high in Pickering Passage than in Peale Passage during 1999 and 2000, respectively. However, total harvest of natural coho salmon in Pickering Passage was 40 and 84 percent of those in Peale Passage during 1999 and 2000, respectively. More natural coho were also caught in September than October 2000, even though natural coho made up a greater percentage of the total catch in October than September. These discrepancies resulted from substantially more coho salmon being caught in Peale Passage than Pickering Passage and in September than October.

The estimated 5 percent or less of the total catch comprised of natural coho salmon in the commercial harvest, resulted in estimates of 131 and 3,808 natural coho salmon being harvested in the Tribes commercial fishery. Although these are small numbers relative to the Tribes total harvest, they are a relatively large component of the south Sound escapement. The Washington State Department of Fish and Wildlife (WDFW) estimated escapement (both natural and hatchery) in area 13D-K streams to be 800 coho in 1999 and 2,942 (preliminary) in 2000. If we

assume for the moment that all these fish were natural origin, the natural coho salmon intercepted in the commercial fishery represented 16 and 129 percent of the natural coho salmon escapement in 1999 and 2000, respectively. Results from this study suggest hatchery origin coho salmon make up a substantial component of the overall escapement. Thus, natural coho salmon intercepted in the commercial fishery likely represented a much larger component of the overall escapement than produced by these estimates.

The accuracy of these estimates are dependent upon the accuracy of the classification of origin using visual scale analysis and the accuracy of the reported catch locations by Tribal fishers. The low harvest numbers in 1999 resulted in less than 100 coho salmon being sampled for scales in Pickering Passage during September 1999. This was less than the goal of 100-150 fish for each catch area and time period, which we estimate would have produced accuracies of 10-12 percent 95 percent of the time. However, sample sizes exceeded this goal during all other area and time sampling strata by as much as three times. Thus, the overall accuracy of the estimated contribution of natural and hatchery coho salmon should be well within the 10-12 percent accuracy desired.

We could not estimate variances for estimates derived during this study, since validation sets of scales specific to south Sound natural and hatchery coho stocks were not obtained. We were able to test the accuracy during 1999, because most coho salmon sampled for scales were also classified as either having an adipose fin or having a clipped adipose fin (hatchery). Coho with clipped adipose fins that were subsequently classified as natural or hatchery provided an opportunity to assess the accuracy of the scale reading methodology. This test showed that hatchery fish were correctly classified about 93 percent of the time. This is within the range (90-94%) observed in other locations in Washington State (NRC 1997). However, these estimates could not be used to calculate variances because they were not independent from the classification data sets (they were the same data set) (Pella and Robertson 1979, Cook 1982). Even if these samples were used to calculate variances for hatchery fish, no such data set exists for south Sound natural stocks. Variation in the accuracy of classifying natural coho salmon was greater than that of hatchery coho salmon (86-99%) in Grays Harbor and Hood Canal (NRC 1997). Therefore, using a state wide average accuracy would be totally meaningless for calculating the variances of our estimates. Given the large sample sizes obtained for most catch areas and time period, our estimates are likely within the 10-12 percent accuracy estimated if 100-150 fish were sampled for each area and time.

It's impossible to assess the accuracy of the reported catch. It's obvious that there are errors in the reported catch among areas. For example, 265 coho salmon were sampled for scales from southern Case Inlet during 2000. However, only 119 coho salmon were reported caught by beach seines from southern Case Inlet during 2000. These types of errors arise from fishers that have caught fish in several different areas during a single day. Most fishers don't keep track of how many fish they catch in each area during a given day. Therefore, the catch is recorded as having been harvested from only one area. Another source of error is from the buyer listing the catch area as Peale Passage without asking or being corrected by the fisher. This occurs since most fisher's fish in Peale Passage.

Errors resulting from fisher's fishing in more than one area on a given day were likely larger in 1999 than 2000. Fisher's tend to move more often when fewer fish are present, as was the case in 1999. Catches recorded for each month are likely much more accurate than those recorded for each area. These estimates would only be inaccurate if catch went unreported. This type of error is likely extremely small.

Recoveries of straying hatchery fish from local streams varied among streams and years. This is consistent with findings of other studies that found that some streams attract more strays than other apparently similar streams (Quinn et al. 1991, Hard and Heard 1999). Straying hatchery fish made up a larger proportion of the total natural escapement in Mill and Cranberry Creeks' during 1999 when run size was extremely small than in 2000. This is consistent with observations that straying by Chinook salmon in southeast Alaska increased as run size decreased (Hard and Heard 1999). Straying hatchery coho accounted for 5.33 to 60.67 percent of sampled fish in streams with at least 10 coho sampled. NRC (1997) found that net-pen coho made up more than 50% of recovered salmon within 10 miles of net-pens in Hood Canal and within 15 miles of the closest hatchery facility in Grays Harbor. However, they observed few hatchery coho in Westport area streams within 10-15 miles of the net-pens. They attributed this to the poor quality of spawning habitat available in these streams. Rensel et al. (1988) estimated that Squaxin Island net-pen strays contributed between 700 and 4,000 coho salmon annually between 1977 and 1982. Estimated mean run size during this period was 7,833 coho salmon (WDFW et al. 1992). Based on these estimates, Squaxin net-pen coho salmon contributed about 9 and 51 percent of the total escapement to south Sound streams during this time period. Thus, the contribution of hatchery strays does not appear to have increased substantially since the Rensel et al. (1988) study, even though releases from the net-pens has increased about 10-fold since the study was completed.

Calculating the total number of hatchery strays to local streams during this study is somewhat problematic and could be completed using multiple methods. All estimates of hatchery straying observed in the sample streams could be combined to estimate the overall percent of hatchery fish in the escapement. An advantage of this method is that relatively large sample sizes ( $n = 214$  for 2000) for the entire area can be obtained, which would result in relatively small variances for the estimates. If we combine the foot survey data with the weir data for 2000, we find that 67 of 208 (32.2%) coho salmon sampled in local streams were of hatchery origin. Simply multiplying this estimate by WDFW's preliminary total escapement estimate for 2000 (2,942) provides an estimate of 947 hatchery fish in the escapement. However, this method assumes equal distribution of hatchery fish among local streams. This is an inappropriate assumption based on the results of this study.

An alternate method would be to adjust the area-under-the-curve estimates obtained for each of the eight index sections surveyed, by the proportion of hatchery fish observed in samples collected from each individual stream. A benefit of this method is that it takes into account the variation observed in hatchery coho salmon contribution to escapement among the different streams. A disadvantage of this method is the relatively small sample sizes that would be

expected from each individual stream ( $n = 1$  to 80 for the current study), which would result in relatively large variances around the estimates. Samples were not collected in all eight of the index streams (or basins) used to estimate coho salmon escapement in area 13D-K streams during either foot or weir surveys. Samples for hatchery contribution were not made for all eight index streams used to estimate escapement in area 13D-K streams. Therefore, we did not estimate hatchery contribution using this method.

### III.5. Management Implications

The goal of the Squaxin Island Tribe is to maximize harvest of net-pen coho salmon, while providing protection for natural coho salmon in south Sound streams. To this end, the Tribe does not allow harvest in terminal inlets of Deep South Sound. Natural coho salmon constituted a very small percent ( $<5\%$ ) of the total harvest during both years. This resulted in estimated harvest of 131 and 3,808 natural coho during the 2000 commercial season. Although not large numbers of coho salmon, they represent a significant proportion of total estimated escapement (natural plus hatchery) observed in local streams (16 to 129%). Closing terminal inlets to harvest obviously provides some protection for natural producing stocks. However, this management strategy alone may not fully achieve the goal of protecting natural coho stocks in local south Sound streams.

The current mass marking of coho salmon throughout Washington State, including the Squaxin Island net-pens, offers the Tribe a management alternative to provide additional protection for natural coho salmon. A majority ( $>95\%$ ) of the Tribes commercial harvest is completed using beach seines. This fact along with mass marking of net-pen coho salmon provides an opportunity to release natural coho (non adipose clipped coho). An additional 3,808 natural coho salmon would have been available for escapement into south Sound streams if they had been released during the 2000 commercial season. This represents 129 percent of the total (hatchery plus natural) escapement into south Sound streams during 2000. These fish would obviously suffer some unknown mortality prior to entering local streams as a result of catch-and-release mortality, and mortality due to sports harvest and predation. Releasing natural coho salmon harvested during 2000 would have cost Tribal fishers \$13,102. This estimate assumes all the estimated natural coho salmon caught during the 2000 commercial season were released, these fish averaged 7.48 pounds, and were sold at an average price of \$0.46 per pound, which were the averages observed during the 2000 commercial coho season.

The Tribe should investigate the survival rate of natural coho salmon caught and released during the commercial seine fishery. One would expect relatively good survival of coho caught and released during a beach seine fishery. However, these fish may be subjected to multiple catch-and-release episodes prior to entering the protected terminal inlets. This may reduce the overall benefits of the required release of natural origin coho salmon.

The results of this study did not suggest any specific limited catch area or time period closures that would provide obvious protection for natural coho salmon. The proportion of the total catch

constituted by natural coho salmon doubled in October relative to September, and proportionally more natural coho salmon were harvested in Pickering Passage than any other catch area, especially in October. However, the total harvest of natural coho salmon was only slightly greater due to reduced harvest levels. These results suggest that limited closures in Pickering Passage during October would likely provide the most benefit for natural coho salmon. The relatively large increase in the cumulative percent of natural coho salmon caught after about October 10 during both years also suggests that limited closures after this date may be beneficial. Although these periodic closures may benefit natural coho salmon escapement, it may also result in increased straying of hatchery coho salmon into local streams.

The issue of straying by hatchery coho salmon into local south Sound streams is a more difficult issue to address. There is still some disagreement regarding the benefit/detriment of straying hatchery coho salmon into local south Sound streams. Natural coho salmon populations in Deep South Sound streams were depressed prior to the initiation of the net-pen project in 1974 and have declined further since this time. Low escapement levels prior to the initiation of the net-pen project were the result of aggressive North Puget Sound fisheries and habitat degradation. Reduced natural production since 1974 is due to aggressive harvest of net-pen coho salmon in south Sound and continued habitat degradation. The FAB determination that south Sound coho stocks should be considered nonviable in 1981 and managed for hatchery exploitation rates contributed to these aggressive harvest rates. Many biologists argue that the likelihood of a locally adaptive stock persisting in deep south Sound streams given the low natural production in recent years, intensive harvest, stocking of hatchery fry and smolts, and straying of out-of-basin transplants released from the net-pens is very remote. This camp may argue that straying is beneficial as an alternate method of stocking these local streams (Rensel et al. 1988).

In contrast, some biologists at the National Marine Fisheries Service (NMFS), concluded that coho salmon in the Puget Sound Ecologically Significant Unit (ESU) would likely become extinct in the near future unless current hatchery and harvest management practices were changed and improvements in habitat made (Weitkamp et al. 1995). Under the Endangered Species Act (ESA), the NMFS must consider the entire ESU when determining the impacts/benefits of a program or activity. Thus, NMFS would likely consider the straying of transplanted coho salmon into local south Sound streams as detrimental to coho salmon in the Puget Sound ESU. This determination would be based on the fact that straying of hatchery salmon into streams reduces the fitness of locally adapted stocks (see for example Grant 1997, Hindar et al. 1991). In the case of south Sound, this straying could possibly affect the development of a locally adaptive stock.

Given the potential determinations under ESA and the some benefits of having only locally adaptive stocks spawning in streams, the Tribe would like experiment with how to control the straying of hatchery fish into local streams. This could be a very difficult goal to achieve. The problem is exacerbated by the fact that there is no collection facility for returning adult coho salmon released from the net-pens. Sport and commercial fishers are relied upon to “collect” adults returning to the area.

One solution for reducing straying would be to increase harvest of net-pen coho. This has the obvious disadvantage of increasing the impacts to natural stocks. This would also require terminal inlets to be fished to capture hatchery fish that have escaped the fishery around the net-pens; again increasing impacts to natural coho salmon.

Two alternate and more viable options are the use of chemical attractants at the net-pens to attract coho salmon released from the net-pens back to the site with greater fidelity and development of local brood source. Chemical attractants, either natural or artificial, would likely improve homing fidelity of coho salmon released from the pens. However, straying coho salmon would still likely contribute significantly to local escapement. The fact that hatchery coho salmon stocks are transplanted from areas other than south Sound would still result in undesirable genetic introgression of transplanted coho salmon with local natural stocks.

The development of a local broodstock presents the best overall alternative. First, the genetic impacts of straying net-pen coho salmon developed from a local stock would likely be less detrimental than those resulting from a transplanted stock. Second, homing to the net-pen facility would likely improve. Adult chinook salmon produced from recently transferred gametes strayed twice as much as adults produced from the adults that returned to a newly established hatchery developed from these gametes (Hard and Heard 1999). Development of a local broodstock would require the capture of adult coho salmon appropriate to develop this broodstock, the development of collection facilities or methods (either at a hatchery or at the pen location), and the development of in basin freshwater rearing facilities or isolation units at hatchery facilities outside the basin.

#### **IV. Evaluation**

The goals and objectives of this study were to estimate the abundance and distribution of hatchery and natural coho salmon contributing to the Squaxin Island Tribal commercial fishery; and to assess the straying rate of hatchery origin coho into natural spawning populations in Area 13D-K streams. Although these goals were met, we had hoped for more robust data and results. These goals were met by sampling the Tribes commercial fishery and determining the proportion of natural and hatchery coho salmon in these samples by analyzing scale growth patterns. These data were then used to estimate the total numbers, and spatial and temporal distribution of natural and hatchery coho salmon harvested during the Squaxin Island Tribes 1999 and 2000 commercial coho salmon fisheries.

We were able to estimate numbers of natural and hatchery coho harvested in the different catch areas during two different months (September and October) of each season. Unfortunately, harvest during the 1999 commercial fishing season was the lowest on record. Thus, the accuracy of this data for more normal harvest years is questionable. We also failed to obtain validation sets of scales from local natural and hatchery coho stocks to assess the accuracy of the scale reading methodology. This prevented the calculation of variances for our estimates of natural and hatchery coho harvest. Examination of known hatchery fish during the 1999 commercial

fishery suggests that the accuracy of the methodology for local hatchery stocks was similar to that observed in other areas. This, along with the large sample sizes obtained, should have resulted in accuracies within 10 to 12 percent of the actual value.

We were able to develop rough estimates of hatchery coho salmon straying into local streams. However, the large spatial variability and the low sample sizes limits the overall usefulness of these estimates. We had hoped to sample 100-150 fish in each weir during both 1999 and 2000. However, poor returns prevented us from attaining this goal. These low returns along with the difficulty in finding coho salmon carcasses also resulted in much lower sample sizes and spatial representation in foot survey samples than desired.

The primary goal of this project was to assess the contribution of net-pen coho salmon to the Tribes fisheries and escapement to local streams. However, net-pen coho salmon and other local hatchery stocks could not be differentiated using scale analysis, and small sample sizes prevented adequate numbers of CWTs to be obtained to provide meaningful analyses. Therefore, we had to report the data for hatchery origin fish in general (all hatchery stocks), rather than specifically for net-pen coho salmon.

This report will be distributed to WDFW biologists, Tribal biologists, and Federal fisheries biologist upon request. We will forward copies to specific WDFW biologists with whom we work on a frequent basis to estimate escapement to local streams. Data presented in this report will be the focus of discussions regarding the best method to estimate natural escapement in local streams, and how we account for straying of hatchery stocks. Unfortunately, the quality of the data likely eliminates the possibility of disseminating these results through peer-reviewed publication.

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Table 1. -Total coho salmon catch by gear type and area during 1999 and 2000.

Gear	Area						Grand Total
	13A	13C	13D1	13D2	13D3	13D4	
1999							
Seine	0	584	742	539	3156	0	5,021
Set net	218	0	0	9	34	0	261
Total 1999	218	584	742	548	3190	0	5,282
2000							
Seine	0	0	6,722	28,038	41,085	119	75,964
Set net	0	0	0	1,458	270	155	1,883
Total 2000	0	0	6,722	29,496	41,355	274	77,847

Table 2.-Number<sup>1</sup> of coho salmon sampled from the 1999 and 2000 commercial fishery classified as natural and hatchery for each catch area and month using visual scale analysis. The number of fish originally classified as unknown is also shown. These fish were separated into natural and hatchery groups based on the proportions of hatchery and natural coho salmon that could be classified.

Period	Origin	Area				Total
		Dana Passage (13D1)	Pickering Passage (13D2)	Peale Passage (13D3)	Southern Case (13D4)	
1999						
September	Natural	13	2	12	0	27
September	Hatchery	349	69	590	0	1,008
September	Unknown	30	5	43	0	78
September	Total	362	71	602	0	1,035
October	Natural	10	18	12	0	42
October	Hatchery	182	241	472	2	895
October	Unknown	9	17	27	0	53
October	Total	192	260	485	0	937
1999 Total		554	331	1,087	2	1,974
2000						
September	Natural	6	8	11	3	27
September	Hatchery	154	172	231	81	591
September	Unknown	9	10	23	6	48
September	Total	160	180	242	84	666
October	Natural	10	46	25	18	94
October	Hatchery	316	610	495	163	1,487
October	Unknown	26	34	29	13	102
October	Total	326	656	520	181	1,683
2000 Total		486	836	762	265	2,349

<sup>1</sup>Rounded to the nearest whole number after coho classified as unknown were grouped into natural and hatchery categories based on the proportions of natural and hatchery coho observed in the samples that could be classified.

Table 3.-Estimated percent of natural and hatchery origin coho salmon in samples for each catch area during September and October of the 1999 and 2000 commercial fishing season based on visual scale analysis.

Month	Origin	Catch Area				Total
		Dana (13D1)	Pickering (13D2)	Peale (13D3)	S. Case (13D4)	
1999						
September	Natural	3.61	3.03	1.97	N/A	2.41
September	Hatchery	96.39	96.97	98.03	N/A	97.59
October	Natural	5.46	7.41	2.62	0	3.69
October	Hatchery	94.54	92.59	97.38	100	96.31
Total	Natural	4.18	5.38	2.25	0	2.96
Total	Hatchery	95.82	94.62	97.75	100	97.04
2000						
September	Natural	3.97	4.71	4.57	3.57	4.55
September	Hatchery	96.03	95.29	95.43	96.43	95.45
October	Natural	3.00	7.01	4.89	10.12	5.95
October	Hatchery	97.00	92.93	95.11	89.88	94.05
Total	Natural	3.70	5.77	4.70	10.12	5.01
Total	Hatchery	96.30	94.23	95.30	89.88	94.99

Table 4.-Estimated total catch of natural and hatchery origin coho salmon for each catch area during September and October of the 1999 and 2000 commercial fishing season.

Month	Origin	Catch Area				Total
		Dana (13D1)	Pickering (13D2)	Peale (13D3)	S. Case (13D4)	
1999						
September	Natural	19	7	34	N/A	60
September	Hatchery	503	234	1,713	N/A	2,450
October	Natural	12	22	37	N/A	71
October	Hatchery	208	276	1,372	N/A	1,856
Total	Natural	31	29	71	N/A	131
Total	Hatchery	711	510	3,085	N/A	4,306
2000						
September	Natural	195	726	1,120	N/A	2,041
September	Hatchery	4,723	14,698	23,412	N/A	42,833
October	Natural	54	892	809	12	1,767
October	Hatchery	1,750	11,722	15,744	107	29,323
Total	Natural	249	1,618	1,929	12	3,808
Total	Hatchery	6,473	26,420	39,156	107	72,156

Table 5.-Total catches of each salmonid species observed in Mill and Cranberry Creeks during 1999 and 2000.

Stream	Coho	Chum	Cutthroat	Sockeye	Steelhead
<b>1999</b>					
Mill	12	240	48	1	1
Cranberry	20	1	0	0	7
<b>2000</b>					
Mill	43	4,649	110	0	0
Cranberry	75	1	0	0	2

Table 6.-Number (percent) of coho salmon caught in Mill and Cranberry Creeks' classified as natural, hatchery, and unknown during 1999 and 2000.

Stream	Natural	Hatchery	Unknown	Total
<b>1999</b>				
Mill	3 (25%)	7 (58%)	2 (17%)	12
Cranberry	14 (70%)	2 (10%)	4 (20%)	20
<b>2000</b>				
Mill	37 (86.1%)	5 (11.6%)	1 (2.3%)	43
Cranberry	66 (88%)	4 (5.33%)	5 (6.67%)	75

Table 7.-Number coho salmon carcasses examined for adipose marks, and the number and percent of natural and hatchery coho salmon in the sample obtained during foot surveys during 2000.

Stream Name	Inlet	Number Sampled	Number Unmarked	Number Marked	Percent Hatchery
Woodland	Henderson	9	1	8	88.89
Skookum Trib	Skookum	1	1	0	0.00
Skookum	Skookum	6	4	2	33.33
Schumacher	Case	1	1	0	0.00
Rocky	Case	79	31	48	60.76
Grand Total		96	38	58	60.42

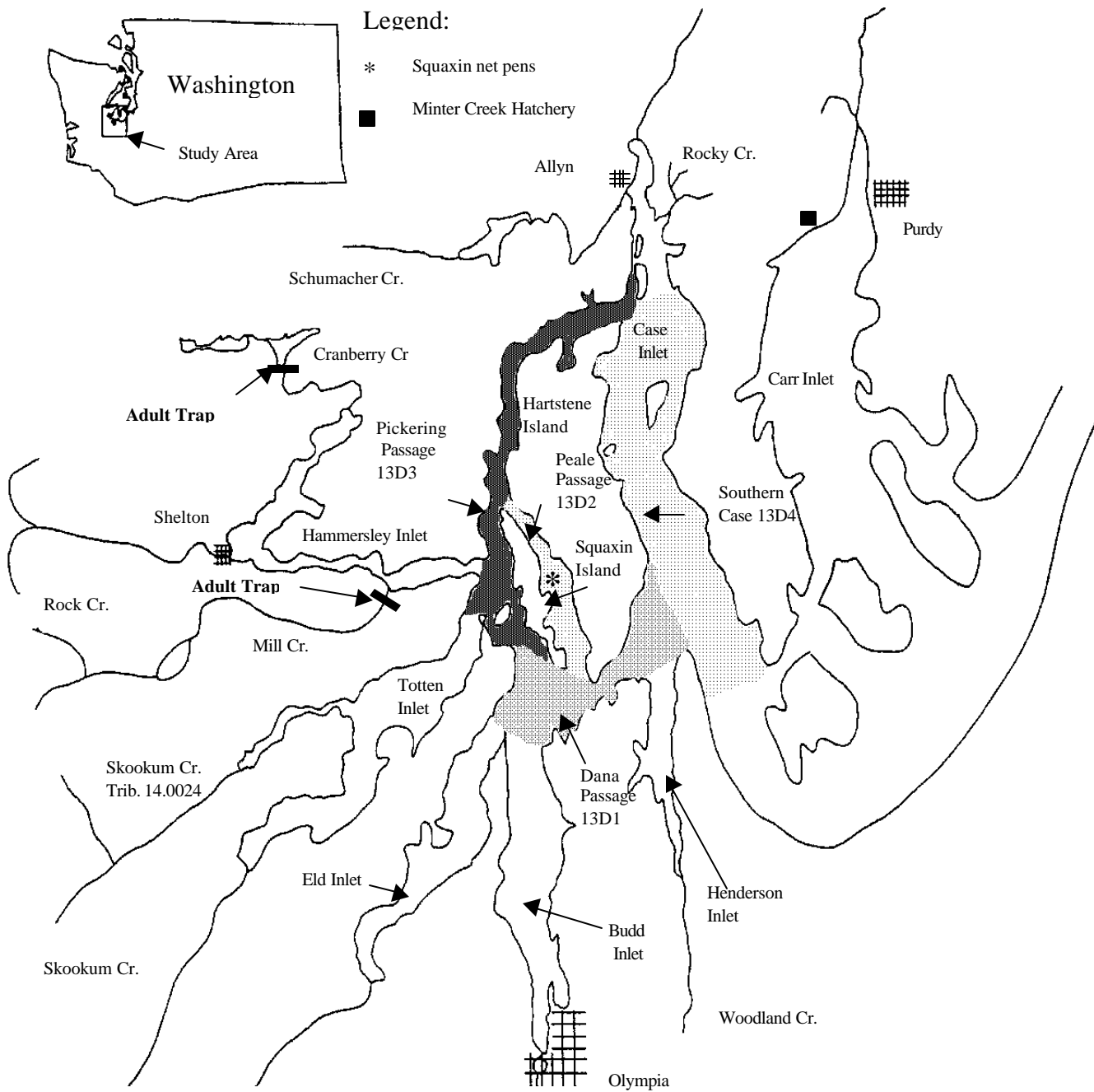


Figure 1.-Areas where coho salmon were sampled in the commercial fishery (Dana Passage 13D1, Pickering Passage 13D2, Peale Passage 13D3, Southern Case Inlet 13D4), in stream weirs (Cranberry and Mill Creeks), and during foot surveys (Schumacher, Rocky, Woodland, Skookum, Skookum Tributary 14.0024, and Rock Creeks).

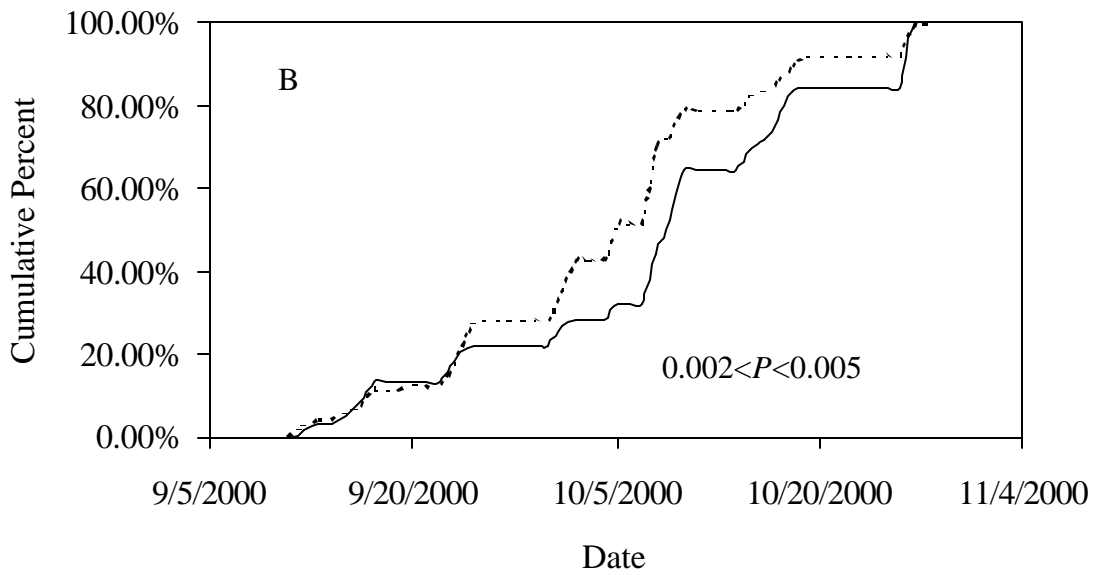
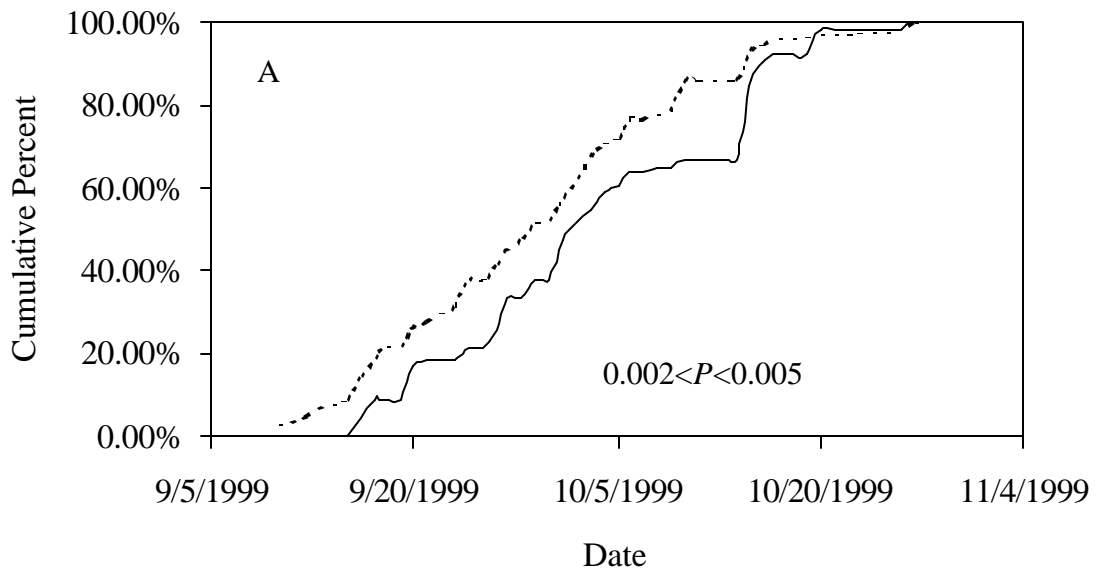


Figure 2.-Cumulative percent of hatchery and wild coho salmon sampled for scales during 1999 (A) and 2000 (B) commercial fishery.